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Optical Apparatus

BACKGROUND OF THE INVENTIONField of the Invention

5 This invention relates to an optical apparatus for observation such as a telescope having the image vibration correcting function of detecting the amount of vibration of the optical apparatus, and deflecting the optical axis of the optical apparatus so as to
10 hold the optical image of the optical apparatus always at a predetermined position on the basis of the detection output.

Related Background Art

15 As an apparatus for eliminating the image vibration of an optical apparatus for observation, there are known binoculars with an image stabilizer as described in Japanese Laid-Open Patent Application No. 50-5058 wherein a gyroscope is connected to an erect prism supported by gimbals.

20 However, in the image stabilizer using a gyroscope, the rotor of the gyroscope is rotated at a high speed and therefore, much time is required before a motor is fully rotated, and since the prism is floating-supported by gimbals mechanism, sudden
25 panning or tilting, when effected, causes the prism to strike against the inner wall of the optical apparatus, and this has caused a trouble in some cases.

1 Also, after the use of the apparatus, it is necessary
to effect the caging of the gyroscope and operation
is cumbersome. Further, the gyroscope requires a
certain degree of mass, and this has led to the
5 disadvantage that the optical apparatus itself becomes
heavy and bulky.

SUMMARY OF THE INVENTION

According to the present invention, a variable
10 angle prism for changing the optical axis of an
observation optical system is disposed between the
objective lens of the observation optical system and
an erect prism and the vertical angle of the variable
angle prism is controlled in conformity with the
15 vibration of an optical apparatus to thereby stabilize
an optical image at a predetermined position and
enable an object to be observed in a good condition
free of image vibration.

20 BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a cross-sectional view of a
telephoto optical system according to an embodiment of
the present invention.

Figure 2 is a block diagram showing the
25 driving system of a construction unit.

DESCRIPTION OF THE PREFERRED EMBODIMENT

1 In an optical apparatus having an objective
lens, ~~a lens for observation and an erect prism,~~
provision is made of vibration detecting means for
detecting the amount of vibration of the optical
5 apparatus, a variable angle prism which is means for
changing the extended optical axis of said objective
lens, and drive control means for driving said
variable angle prism on the basis of an output signal
from said vibration detecting means, and said
10 variable angle prism is installed between said
objective lens and said erect prism.

Figure 1 shows the optical cross-section of
a telephoto optical system which is an embodiment of
the present invention.

15 In Figure 1, the reference numeral 1 designates
an objective lens for forming the image of an object.
In some cases, the objective lens is divided into
multiple groups. The letter L denotes the optical
axis of the optical system. The reference numeral 2
20 designates a variable angle prism (hereinafter
referred to as the VAP) which is means for changing
the optical axis (or the optical path). The VAP 2 is
of a construction in which liquid 2d having a uniform
refractive index is enclosed in a bellows vessel 2c
25 having its opposite ends adhesively secured to two
transparent plates 2a and 2b.

The reference numeral 3 denotes an erect prism

1 comprising two prisms spaced apart by a minute
~~distance from each other. The forward prism has an~~
inclined surface on the lower side thereof, and the
rearward prism has a roof surface on the upper side
5 thereof. This erect prism has the action of
inverting an image vertically and rendering the image
erect, and if it has a roof surface, the right and
left will also be inverted. The prisms may be
deformed.

10 The reference numeral 4 designates an
eyepiece for observing therethrough the image formed
by the objective lens 1. The objective lens 1, the
variable angle prism 2, the erect prism 3 and the
eyepiece 4 are disposed coaxially with the optical
15 axis L.

Figure 2 is a block diagram showing a driving
method for the variable angle prism 2. In Figure 2,
the reference numeral 5 designates a control circuit
comprising a microcomputer or the like which governs
20 the vertical angle deflection drive control of the
VAP 2, and the reference numeral 6 denotes a detecting
sensor which is vibration detecting means for detecting
the vibration of the telephoto optical system and
which is mounted on a portion of a telescope body,
25 not shown. Although detailed description of the
vibration detecting sensor 6 is omitted because this
sensor is not directly related with the present

1 invention, a cylindrical case 6a is filled with liquid
6b having a predetermined refractive index, and a
reflective float member 6c rotatable about a
predetermined rotational axis is provided in the
5 liquid 6b. This float member 6a is adapted to be held
at a predetermined position when there is no vibration,
by a close magnetic circuit consisted of a permanent
magnet 6d provided so as to surround the case 6a.
Design is also made such that when vibration occurs
10 to the telescope body and the float member 6c rotates
relative to the case 6a, the position of a spot light
emitted from a light emitting element 6e, reflected
by the surface of the float member 6c and entering a
light receiving element 6f for position detection is
15 varied. Thus, in conformity with the amount of
vibration of the telescope body, the position of
incidence of the light onto the light receiving
element 6f is varied and the output signal thereof is
varied. The output signal from the light receiving
20 element 6f is output to the above-described control
circuit 5 through a position detecting circuit 8 for
detecting the position of the light spot. This output
is representative of the angle of rotation of the
telescope.

25 On the other hand, the VAP 2 is disposed
between the objective lens 1 and the erect prism 3
and in proximity to the erect prism, and a magnetic

1 circuit 10 is driven by a VAP drive circuit 7
controlled by the control circuit 5 in conformity with
the output of a position detecting circuit 8 adjacent
to the vibration detecting sensor 6, whereby a
5 magnetic plate 2f secured to a support plate 2e
coupled to the transparent plate 2a of the VAP 2 which
is adjacent to the objective lens is moved and the
transparent plate 2a is tilted. The magnetic plate
2f is supported on the telescope body, not shown, by
10 a rotary shaft 2g protruded from the transparent plate
2a. Also, the amount of tilt of the transparent plate
2a is detected by a detector which comprises a light
emitting element 11 and a light receiving element
12 and detects at what position on the light receiving
15 surface of the light receiving element 12 the spot-
light of the light emitting element 11 lies, and the
output signal thereof is output to the control circuit
5 through a position detecting circuit 9. At that
time, the control circuit 5 controls the VAP drive
20 circuit 7 and drives the magnetic circuit 10 so that
the difference between the output of the position
detecting circuit 8 adjacent to the vibration
detecting sensor 6 and the output of the position
detecting circuit 9 adjacent to the VAP 2 may be "0",
25 and tilts the transparent plate 2a of the VAP 2.
Although not shown, the transparent plate 2b of the
VAP 2 can be tilted in a direction orthogonal to the

1 direction of tilt of the transparent plate 2a, by a
method similar to the method described above with
respect to the transparent plate 2a. The numeral 2h
designates a rotary shaft provided in the transparent
5 plate 2b. In this manner, the vertical angle of the
variable angle prism 2 is two-dimensionally varied,
whereby the optical axis can be deflected in a
direction to suppress the vibration of image created
by the vibration of the telephoto optical system and
10 as a result, the user of the telephoto observation
apparatus can obtain a stable image free of vibration.
If design is made such that a TV camera can be
mounted rearwardly of the eyepiece 4, an object will
conveniently become observable by a TV monitor.

15 As described above, the variable angle prism
is disposed in the ray converging portion rearward of
the objective lens, whereby there can be realized an
optical apparatus in which the variable angle prism
may be compact and which is excellent in the frequency
20 characteristic which is one of image stabilizing
performances. Also, by the variable angle prism
being disposed forwardly of the erect prism, there is
provided an advantage that the expensive erect prism
need not to become bulky. Thus, by using the variable
25 angle prism, there is obtained the effect that there
can be relatively inexpensively manufacture an
observation apparatus with an image stabilizer which

1 is compact and light in weight as compared with the
aforedescribed example of the prior art.

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